(1)

Communication Engineering

- Noise → is unwanted Signal that affects information, and random Signal.

Noise exist in two types

Internal — External

[1] Internal

① random movement of electrons in electronic devices.

② Caused by (Resistors ; Diodes ; BJTs, ...)

③ Thermal Noise (White Noise ; Gaussian Noise)

④ Shot Noise

[2] External

[1] Man - Made

[2] Caused by (Motors , Generators ; ...)

Noise Level is propotional to :-

[1] Temperature & Band Width

[2] Gain

Noise Disadvantages

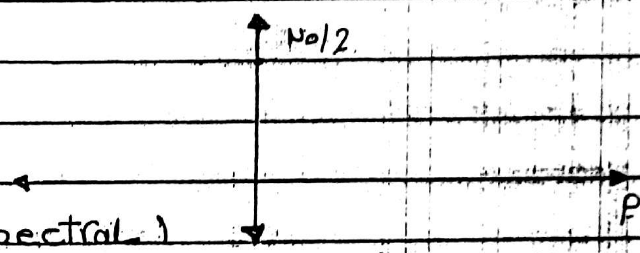
[1] Low system performance

[2] Reciever Cannot detect (Extract)
Signal from noise

[3] Efficiency of system reduced.

The main problem (Additive White Gaussian Noise)
(A.W.G.N.)

Noise power



$P_n = \frac{KT}{2}$ (noise power spectral)

$= \frac{N_o}{2}$ ($N_o = KT$) →

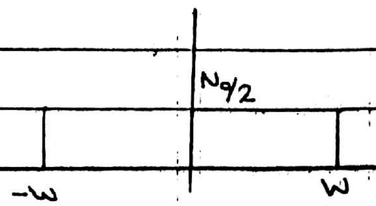
Band Width (B.W) → The width of the modulated Signal

AM → 2W

FM → 2(n)W_m

Filters Are Source of noise :-

(1) Low pass filter (LPF)

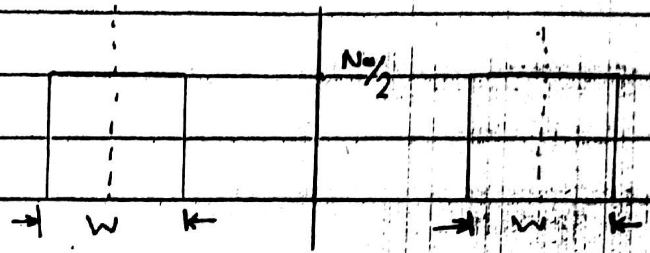


Total Noise $= P_n * \underbrace{2W}_{\text{Band width}}$

$= \frac{N_o}{\cancel{2}} * \cancel{2} W$

$= N_o W$

② Band pass Filter



Total Noise $= P_n * B.W$

$= \frac{N_o}{2} * 4W$

$= 2 N_o W$

* Noise in Continous wave modulation

$P_{DSB} = \frac{A_c^2 m^2}{4} = A_c^2 P \rightarrow$ Signal power

$\rightarrow$ DSB $\rightarrow$ using a Band pass filter

$$SNR\Big|_o = \frac{P_{DSB}}{\text{Total Noise}} = \frac{A_c^2 \cdot P}{2 N_o W}$$

(output)

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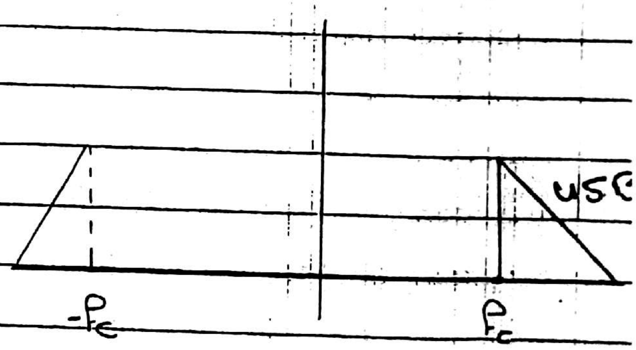
• Figure of merit = $\dfrac{SNR|_{output}}{SNR|_{i}}$

Any reference to compare performance of different modulation systems.

• Figure of merit = $\left.\dfrac{SNR|_{o}}{SNR|_{i}}\right|_{DSB} = 1$

* SSB TC with noise

• Assuming Lower Side band



$$S(t) = \frac{A_c}{2} m(t) \cos(2\pi f_c t) + \frac{A}{2} \hat{m}(t) \sin(2\pi f_c t)$$

Total Power

$$= \frac{A_c^2}{8} P + \frac{A_c^2}{8} P = \frac{A_c^2 P}{4}$$

- in case of SSB

- mean noise filter $= N_o \cdot W$
  ↳ Band Width

$$S.N.R\Big|_{SSB} = \frac{A_c^2 P}{4 \cdot N_o W}$$

- This noise is additive noise :-

$$x(t) = s(t) + n(t)$$

↳ signal after Band pass filter (Any filter)

$\hat{m}(t) \rightarrow$ Hilbert transform of $m(t)$

(shifted by 90°)

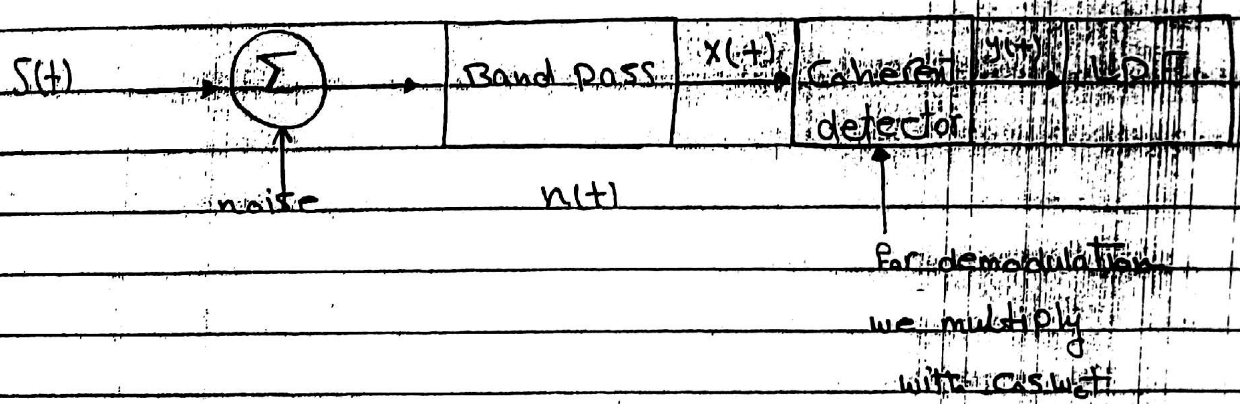
$$\hat{m}(t) = m(t) * \frac{1}{\pi \tau}$$

if get fourier transform.

$$\hat{M}(f) = -j \, Sgn(f) \cdot M(f)$$

$m(t)$ & $\hat{m}(t)$ are orthogonal uncorrelated.

Block Diagram System



For $x(t) = s(t) + n(t)$

$\therefore y(t) = [s(t) + n(t)] \cdot \cos(2\pi f_c t)$

$s(t) = A_c m(t) \cos(2\pi f_c t)$

$n(t) = n_I(t) \cos(2\pi f_c t)$

- After Low pass filter

$$\text{output} = \frac{1}{2} A_c m(t) + \frac{1}{2} n_I(t)$$

$$\therefore P_o = \frac{1}{4} A_c^2 P$$

$$\& P_n = \frac{1}{\cancel{4}} \cdot \cancel{2} N_o W$$

$$\therefore SNR|_o = \frac{P_o}{P_n}$$

$$\boxed{SNR|_o = \frac{A_c^2 P}{2 N_o W}}$$

For DSB SC

$$SNR|_i = \frac{P_s(t)}{N_o W}$$

Sheet # 1

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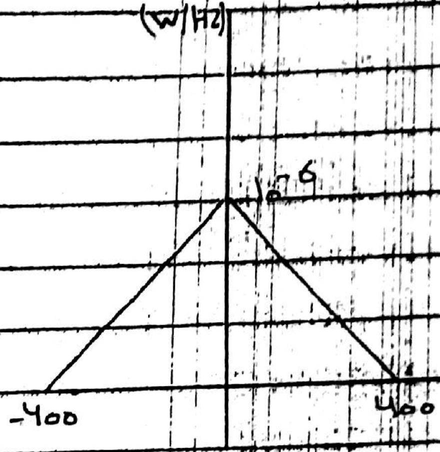

$f_m = 4kHZ$

$f_c = 200\ kHZ$

$P = 10\ watt$

$$SNR|_o = \frac{A_c^2 P}{2 N_o W}$$

$$SNR|_i = \frac{P_s}{N_o W}$$

$$SNR|_o = SNR|_i =$$

$$\frac{N_o}{2} = 10^{-6}$$

$$\therefore N_o = 2 * 10^{-6}$$

$$(f_m)\ W = 4 * 10^3 \quad ??$$

$$SNR|_o = \frac{10}{2 * 10^{-6} * 4 * 10^{3}} = \frac{1}{8 * 10^{-4}}$$

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